Updates on EOS MLS Cloud Algorithms and Scientific Investigations

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Outline:

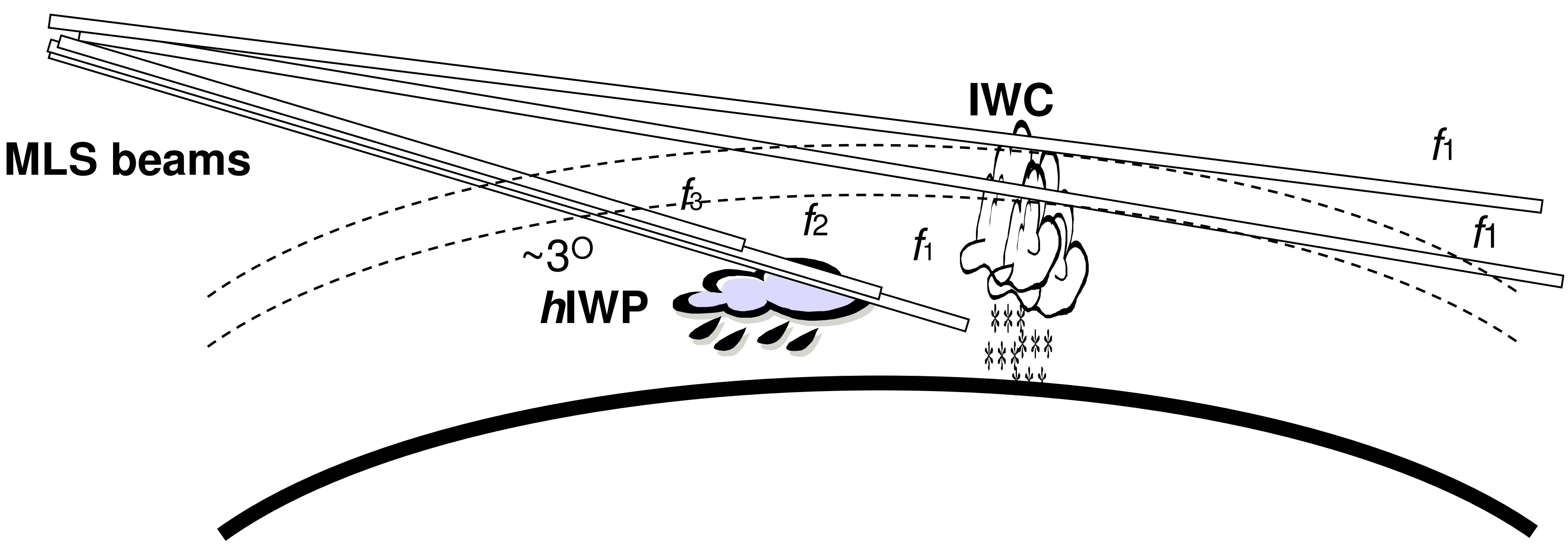
- Evaluations of MLS v1.5 IWC and plans for v2.0 cloud products
- Thoughts on improving IWC accuracy with A-Train measurements
- MLS sciences for better understanding pollution-cloud-precipitation processes

Status of MLS v1.5 IWC

- 1 year of observations (95% processed)
- Files available in IDL save format
  ftp://mls.jpl.nasa.gov/jonathan//mls_cld/V1.5CLD02/
  or email questions to Jonathan.H.Jiang@jpl.nasa.gov
- Caveats on MLS IWC:
  Average over ~200x7x3 km^3
  Dynamic range: ~2 – ~80 mg/m^3
  Pressure range: < 215 hPa
- IWC > ~50 mg/m^3 likely to be underestimated due to saturation
- Initial comparisons with IWC generated by 5 GCMs encouraging (see Li et al. GRL)
- Climatology and seasonal variations of MLS IWC

Plans for v2.0 cloud products

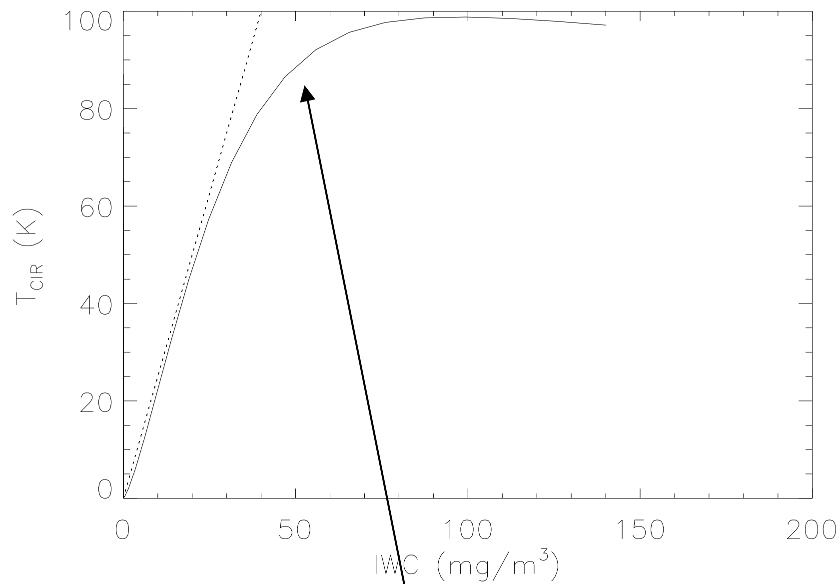
1. Improving IWC (based upon high-z_t measurements)
   More accurate calculation for Tcir (cloud-induced radiances)
   non-linear Tcir-IWC relations
2. Adding *h*IWP retrievals from low-z_t measurements
   multiple frequencies
   different penetration depths
   extended height coverage

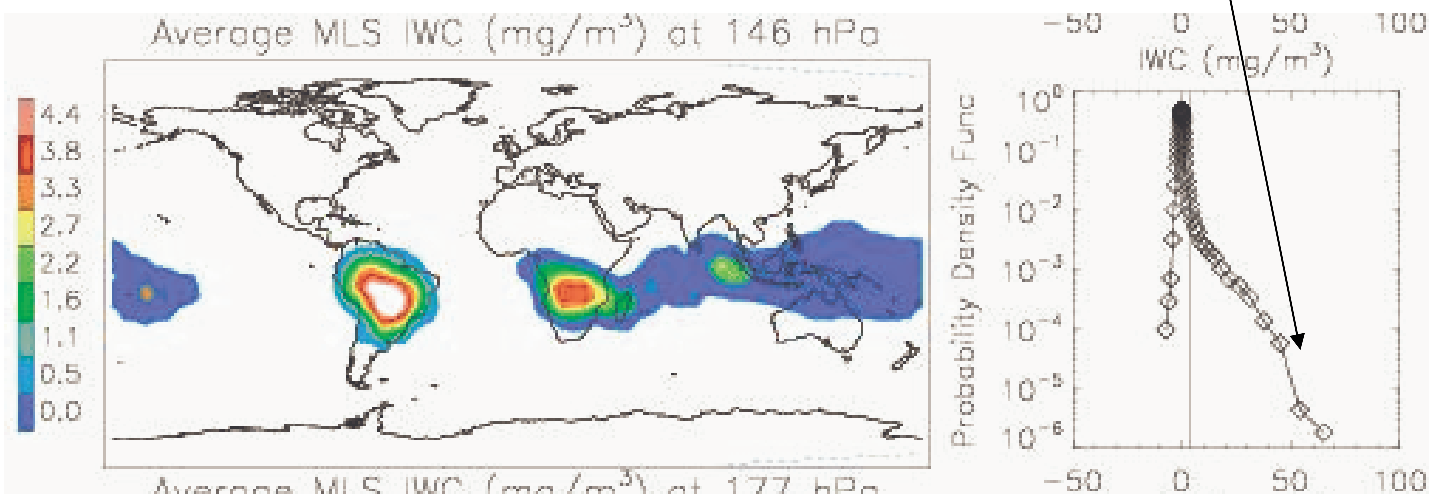


1. Improving IWC

Corrections in v2.0 for saturated cases:

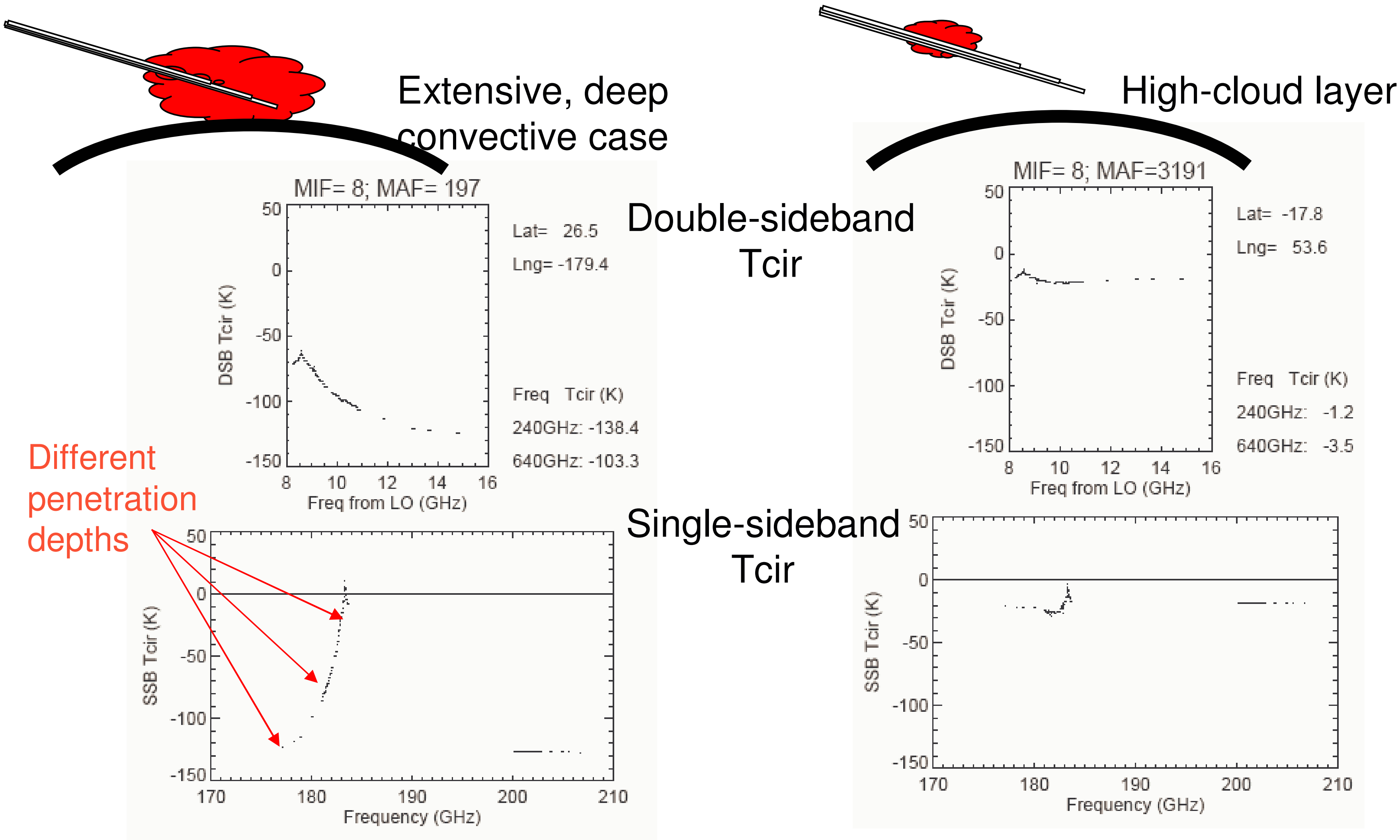
- replace the linear relation with an exponential curve
- latitude dependence and/or more sophisticated scheme

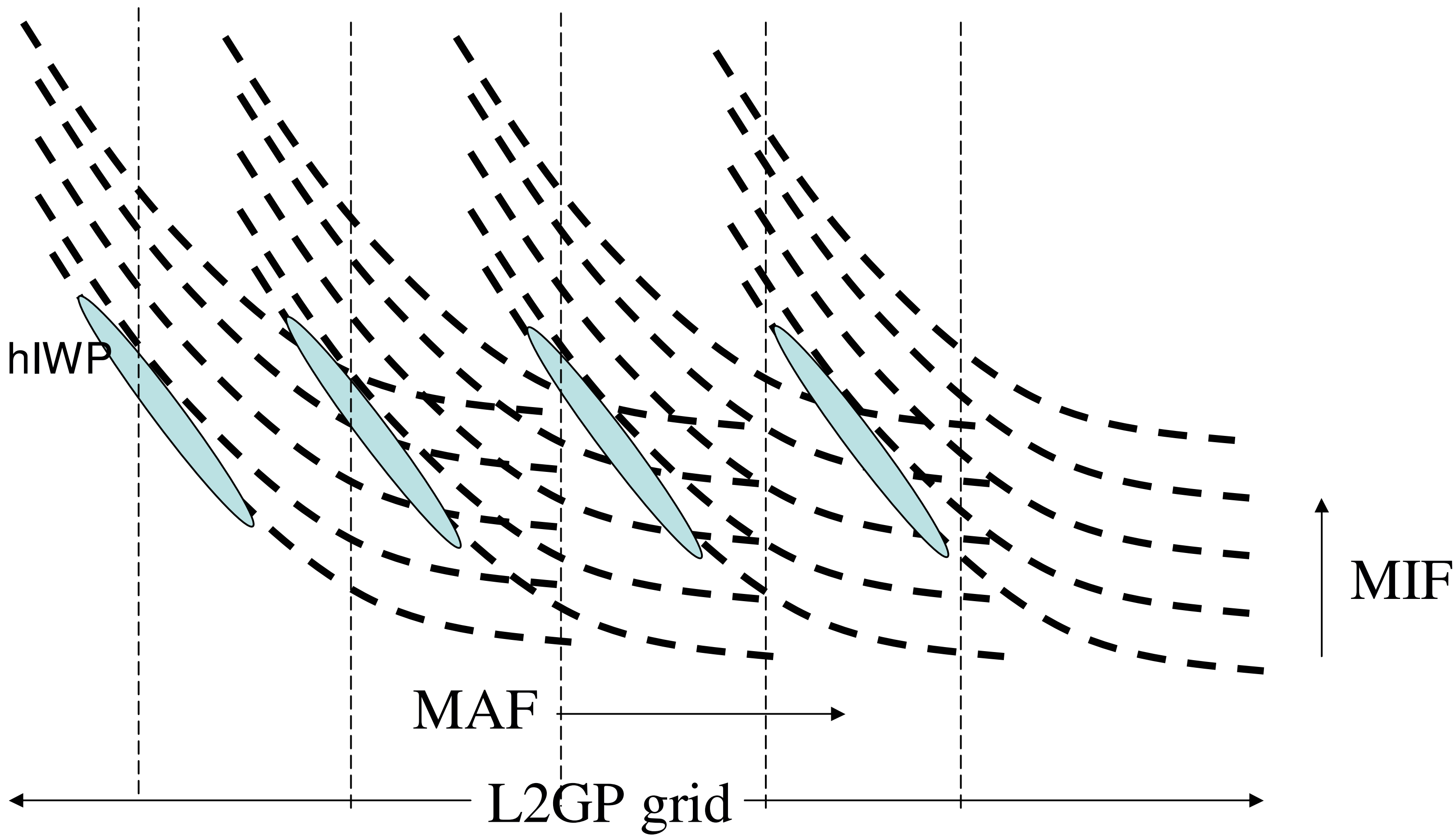




2. Retrieving hIWP

- Key: Double-sideband -> Single-sideband Tcir
- Consistency between 190 GHz and 240 GHz measurements
- Modeled Tcir-hIWP relations



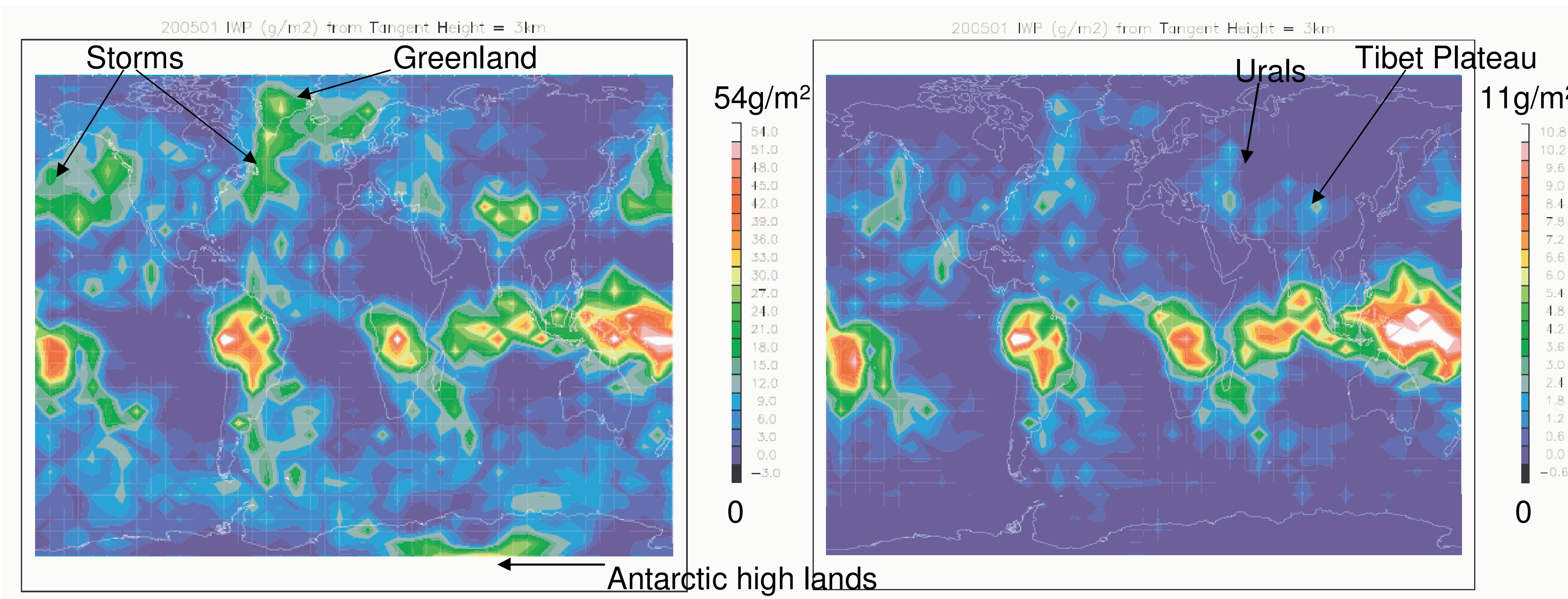

hIWP
MIF
MAF
L2GP grid

Examples of MLS IWP (January 2005)

- Will provide IWP in v2.0 from MLS 118, 190, 240 and 640 GHz window channels, corresponding to the bottom heights of ~14, ~8, ~7, and ~11 km, respectively.
- Need to check consistency between these IWP and the IWP derived from high-ht IWC measurements.

240GHz: IWP above ~7 km

640GHz: IWP above ~11 km



Some Thoughts on Quantifying IWC Accuracy

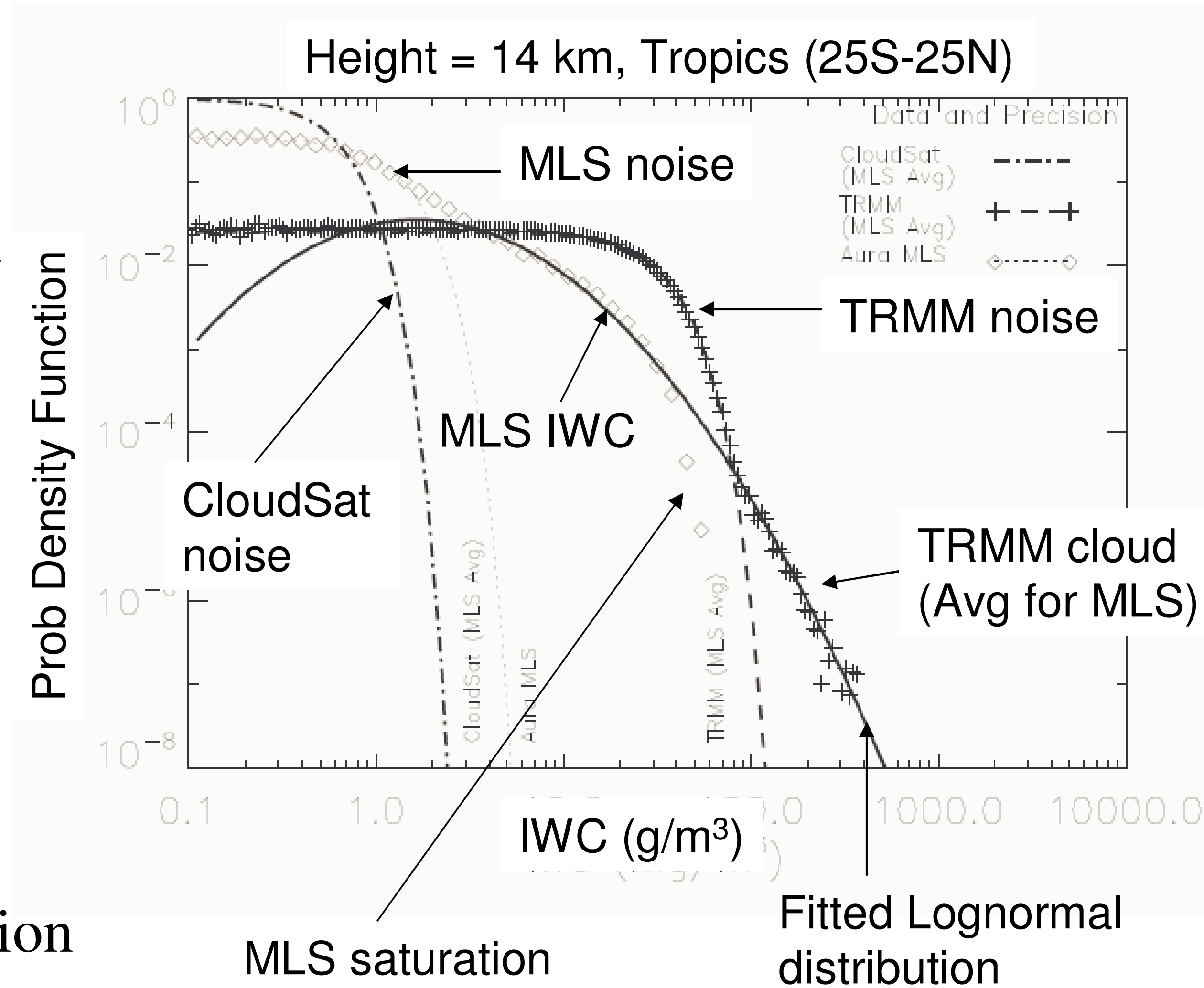
- How to compare different IWC measurements when cloud variabilities (spatial and temporal) are undersampled?
- How to treat measurement noise when different techniques vary substantially?
- How to compare modeled and observed IWCs?

TRMM:

- 4km footprint
- 220 km swath
- 250 m vertical res.
- 28 dBZ
  or ~50 mg/m3 noise

Radar IWC-Z relation:

$$\text{Log(IWC)} = 0.035Z - 1.1$$

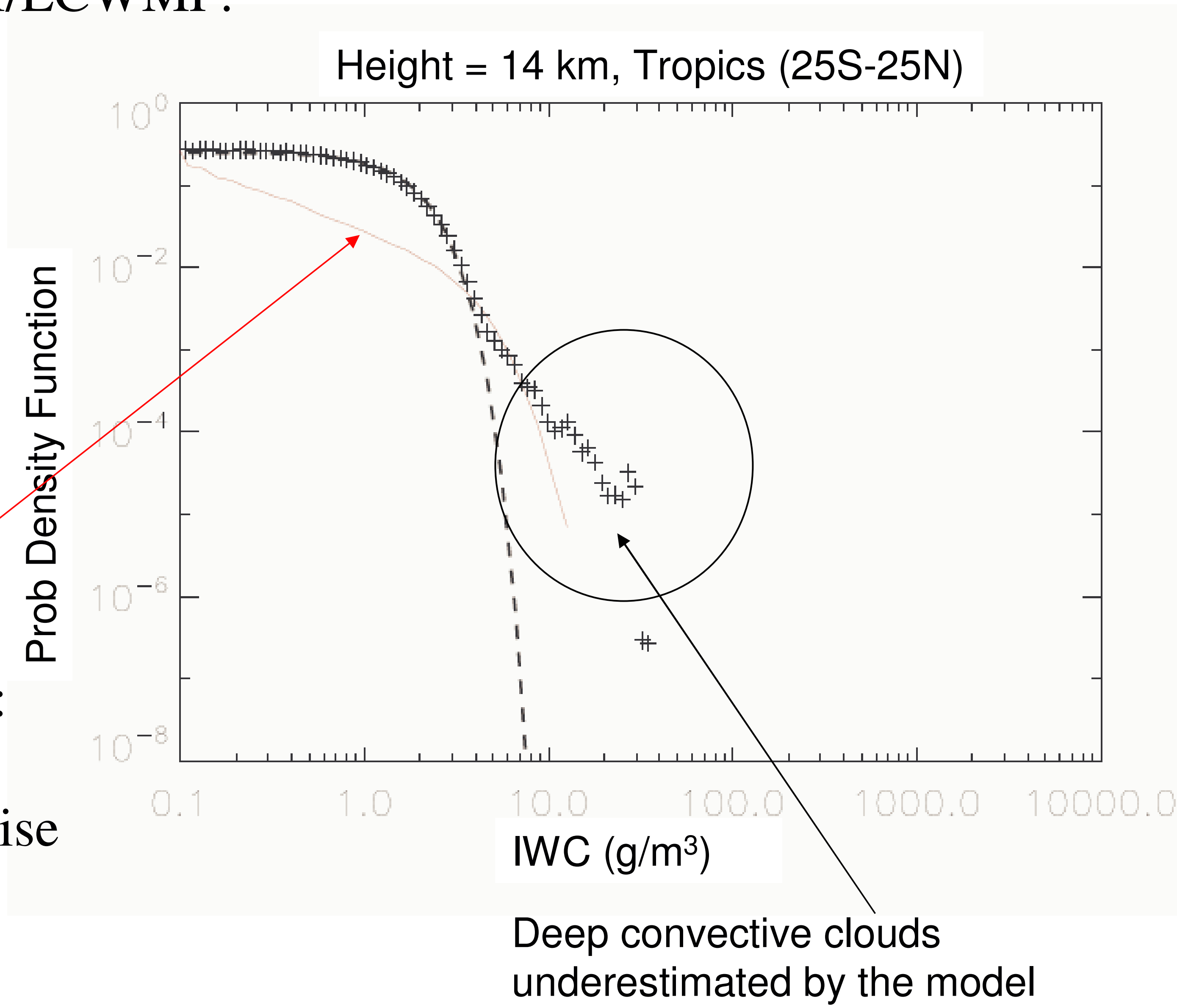


MLS:

- 7 x 200 km footprint
- 3 km vertical resolution
- 2 mg/m^3 noise

TRMM vs GEM/ECWMF:

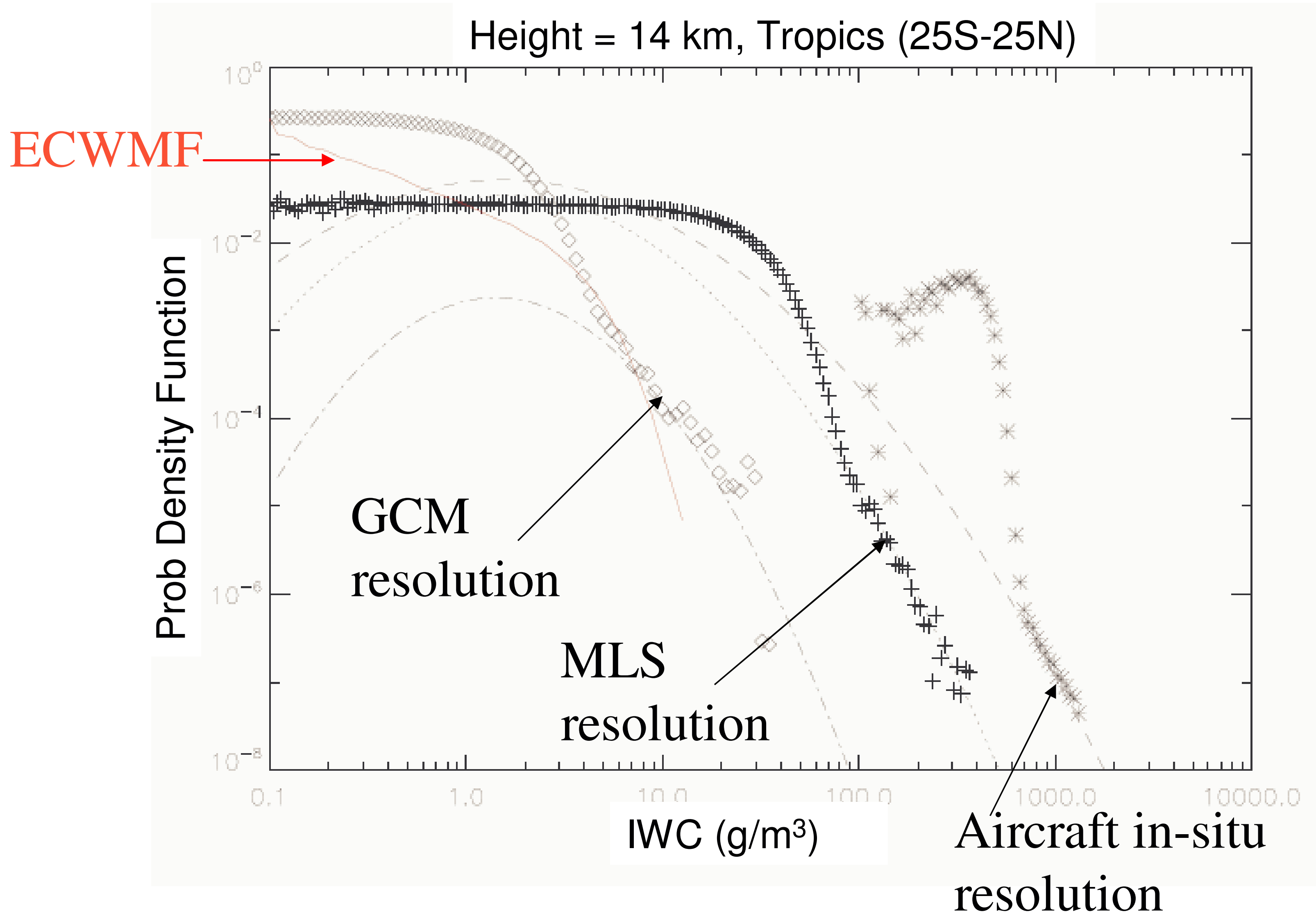
- 4deg x 8deg
- 3 mg/m3 noise



GEM/ECWMF:

- 4deg x 8deg
- 0.1 mg/m3 noise

Inhomogeneity effect:
TRMM IWC PDFs averaged onto different box sizes



A proposal submitted to CloudSat and A-Train data analyses

- Joint statistical analyses of MLS and CloudSat (radar and lidar) data: may need to start from the radar reflectivity dataset since current CloudSat algorithms report only +ve of IWC.
- Statistical analyses of in-situ measurements (A. Heymsfield) from available long-leg aircraft flights to characterize cloud inhomogeneity and IWC PDF.
- Comparisons of IWC statistics between those from space and those from ground-based radars: spatial vs temporal variabilities.

MLS Cloud Sciences:

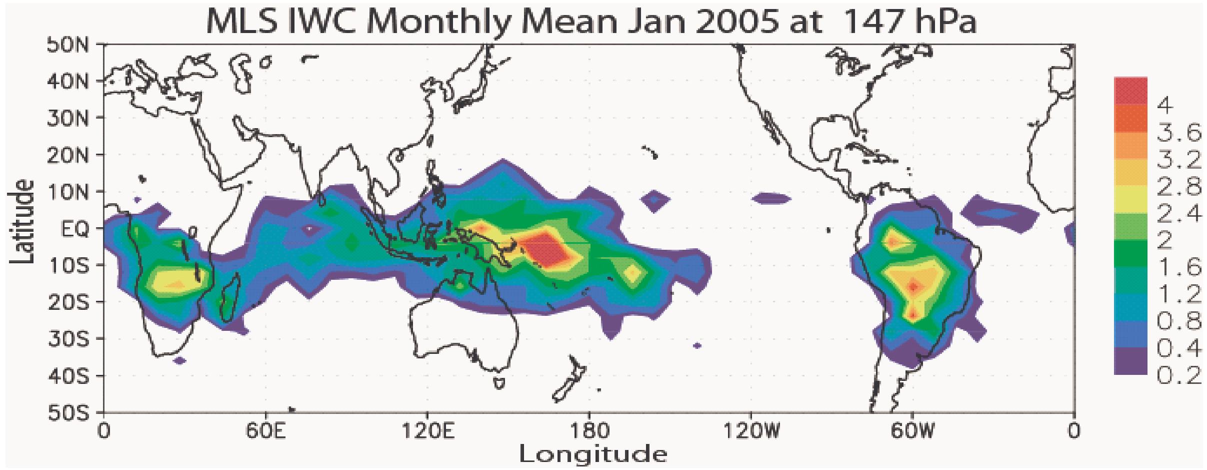
- Climate change, cloud, pollution, and precipitation

MLS vs. GCMs

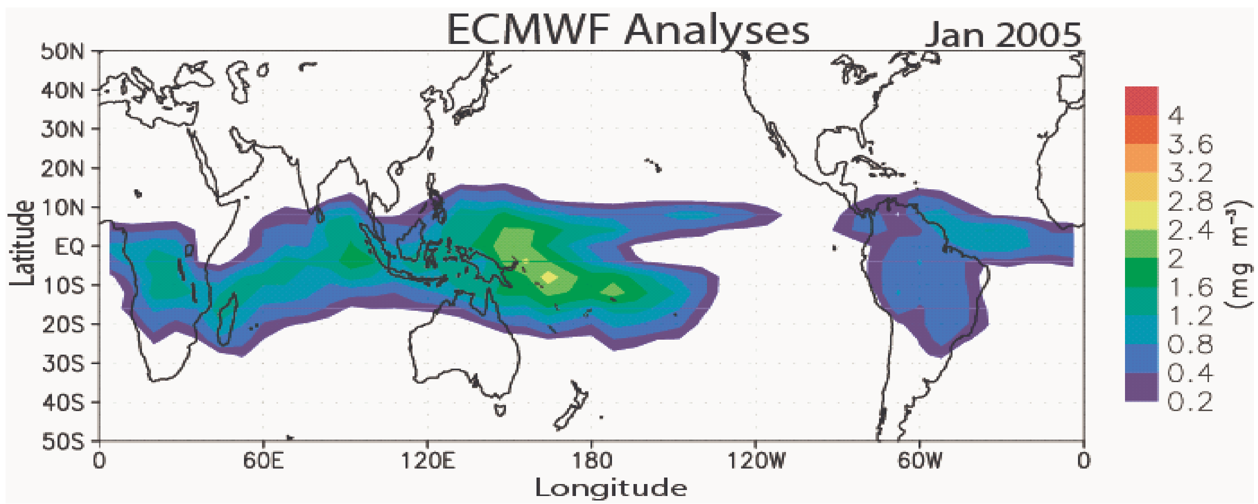
MLS vs ECMWF: January 2005

Li et al. 2005

MLS



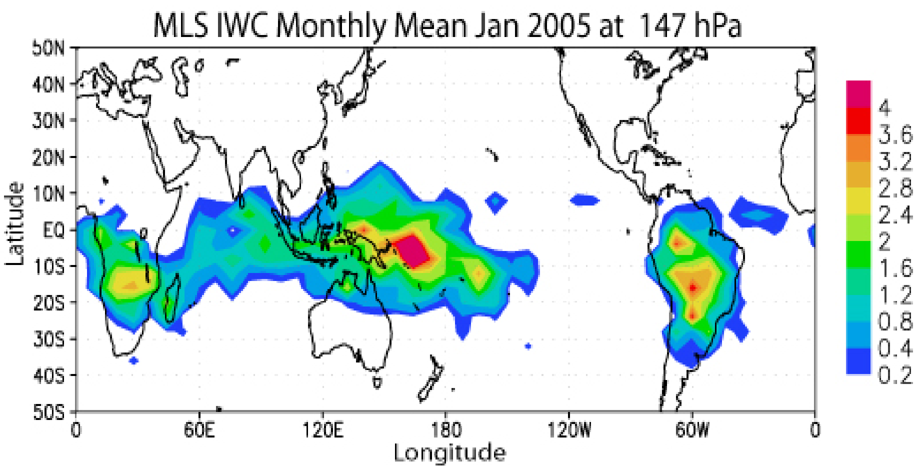
ECMWF

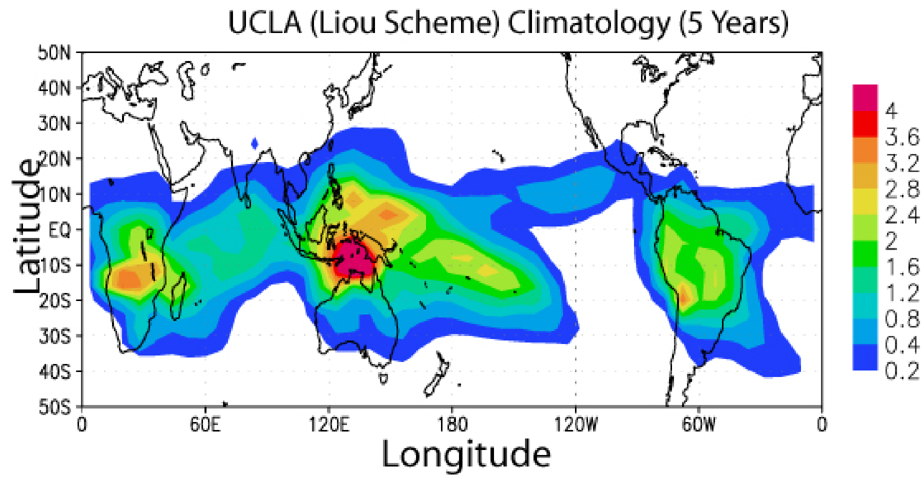


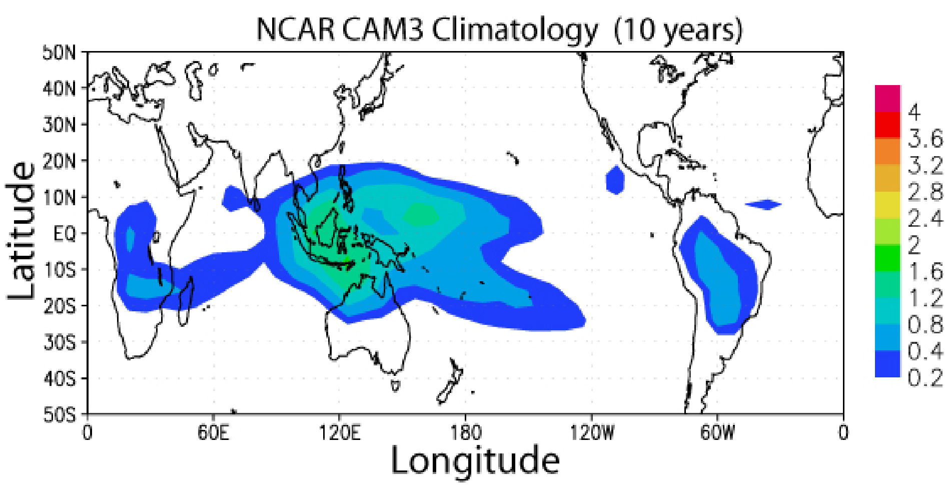
Monthly Mean - MLS values are generally about 2 times larger than ECMWF.

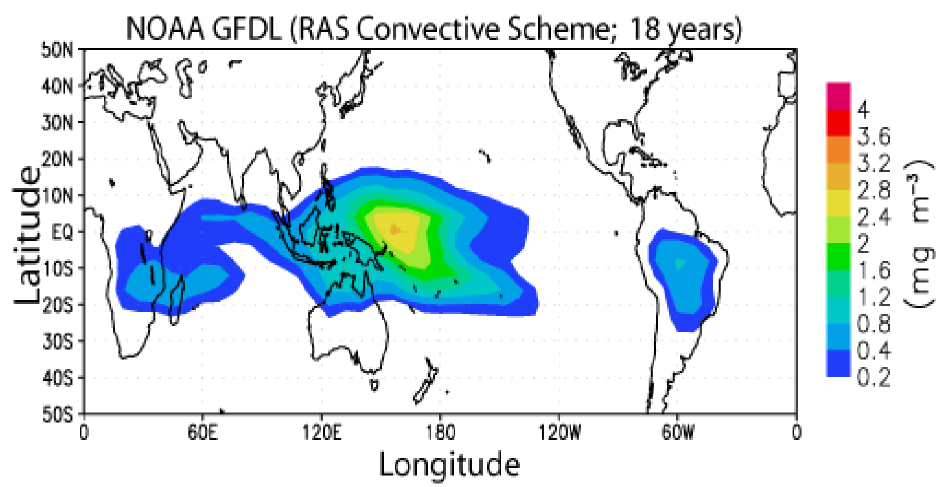
MLS January 2005 vs GCMs Mean January

Li et al. 2005



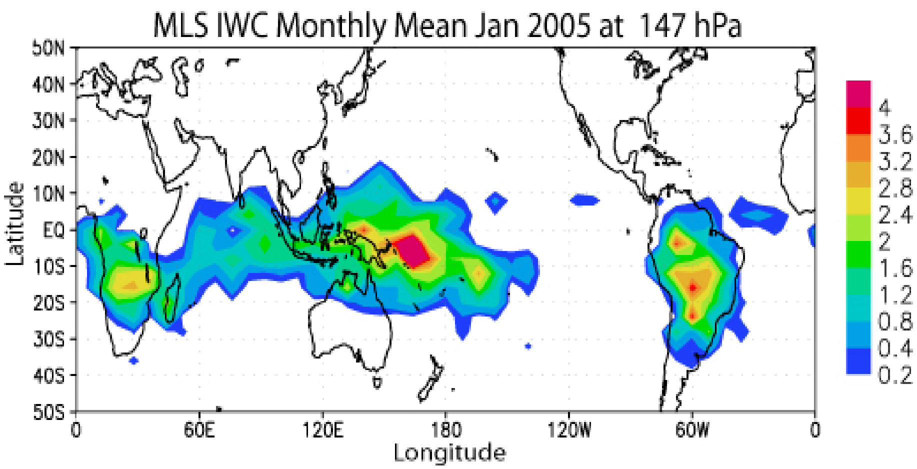


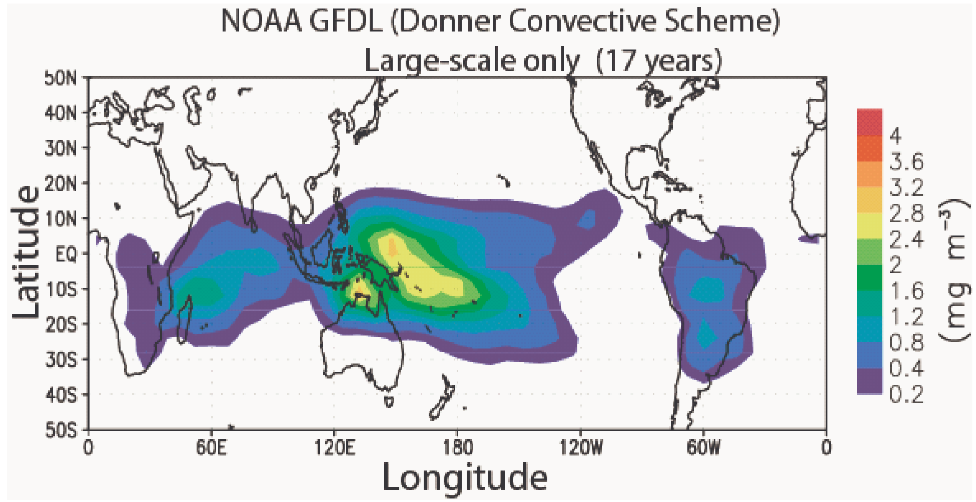


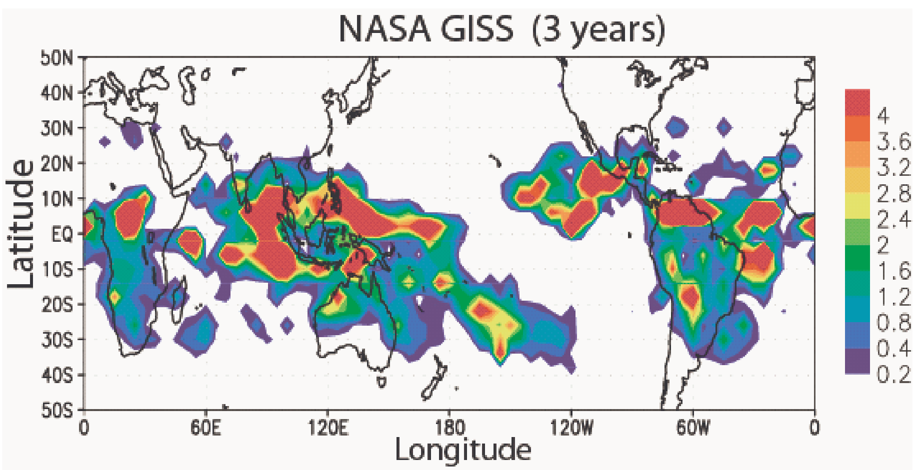


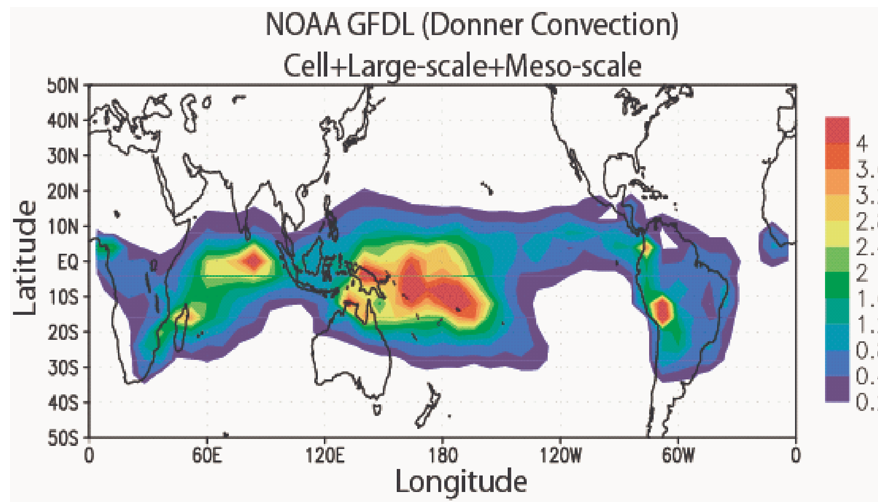
MLS January 2005 vs GCMs Mean January

Li et al. 2005

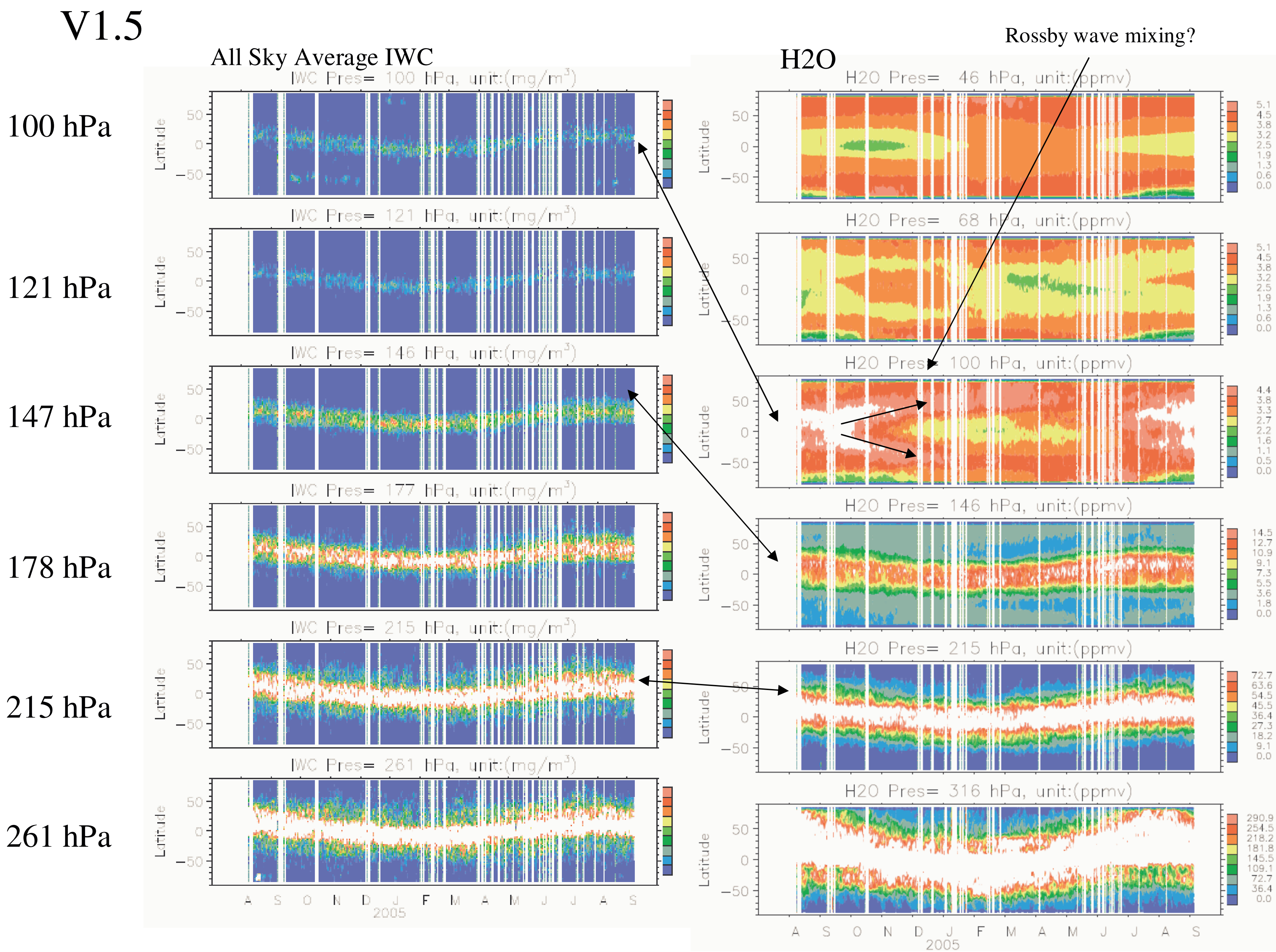


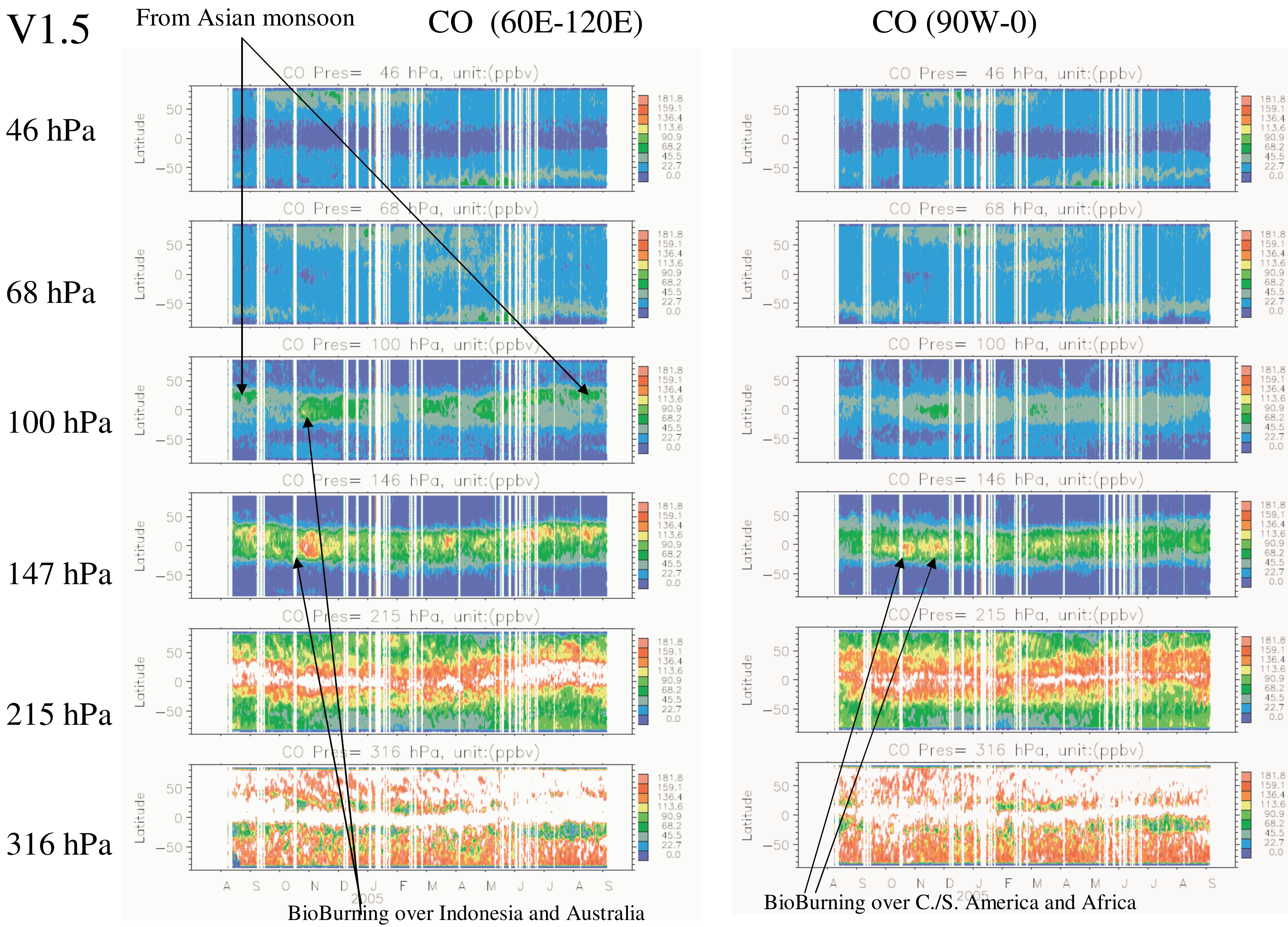






MLS Climatology


V1.5
All Sky Average IWC
H2O
Rossby wave mixing?
100 hPa
121 hPa
147 hPa
178 hPa
215 hPa
261 hPa
IWC Pres= 100 hPa, unit:(mg/m^3)
IWC Pres= 121 hPa, unit:(mg/m^3)
IWC Pres= 146 hPa, unit:(mg/m^3)
IWC Pres= 177 hPa, unit:(mg/m^3)
IWC Pres= 215 hPa, unit:(mg/m^3)
IWC Pres= 261 hPa, unit:(mg/m^3)
H20 Pres= 46 hPa, unit:(ppmv)
H20 Pres= 68 hPa, unit:(ppmv)
H20 Pres= 100 hPa, unit:(ppmv)
H20 Pres= 146 hPa, unit:(ppmv)
H20 Pres= 215 hPa, unit:(ppmv)
H20 Pres= 316 hPa, unit:(ppmv)
Latitude
50
0
−50
A S O N D J F M A M J J A S
2005
5.1 4.5 3.8 3.2 2.5 1.9 1.3 0.6 0.0
4.4 3.8 3.3 2.7 2.2 1.6 1.1 0.5 0.0
14.5 12.7 10.9 9.1 7.3 5.5 3.6 1.8 0.0
72.7 63.6 54.5 45.5 36.4 27.3 18.2 9.1 0.0
290.9 254.5 218.2 181.8 145.5 109.1 72.7 36.4 0.0

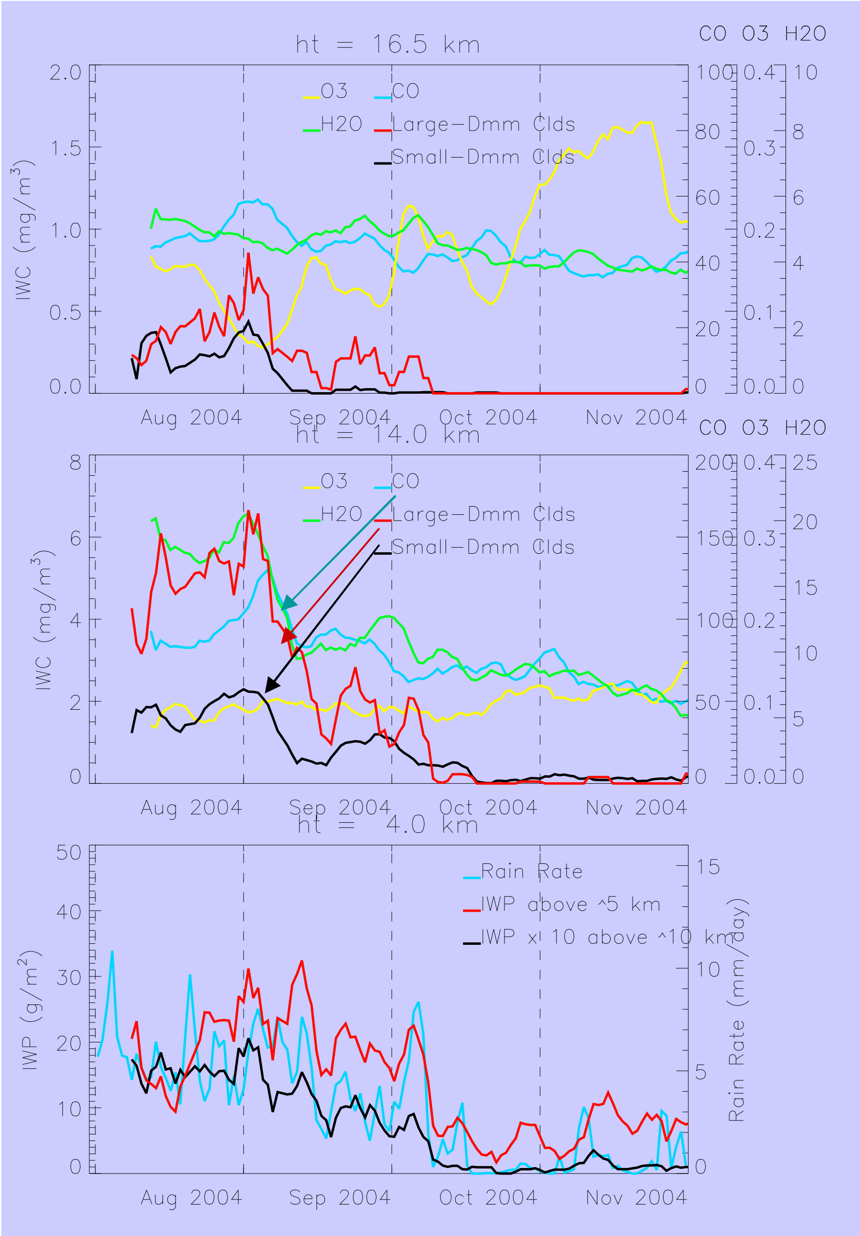


V1.5
From Asian monsoon
CO (60E-120E)
CO (90W-0)
46 hPa
68 hPa
100 hPa
147 hPa
215 hPa
316 hPa
CO Pres= 46 hPa, unit:(ppbv)
CO Pres= 68 hPa, unit:(ppbv)
CO Pres= 100 hPa, unit:(ppbv)
CO Pres= 146 hPa, unit:(ppbv)
CO Pres= 215 hPa, unit:(ppbv)
CO Pres= 316 hPa, unit:(ppbv)
Latitude
50
0
−50
181.8
159.1
136.4
113.6
90.9
68.2
45.5
22.7
0.0
A S O N D J F M A M J J A S
2005
BioBurning over Indonesia and Australia
BioBurning over C./S. America and Africa

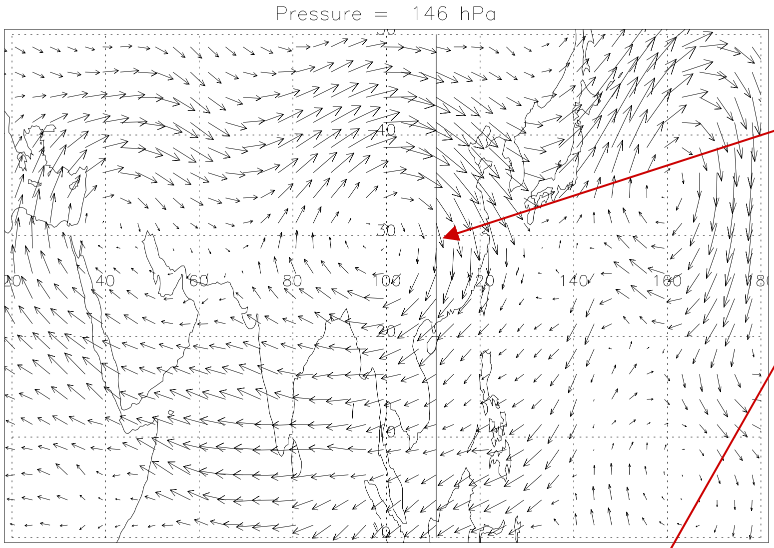
Upper-Trop Clouds, Pollution and Precipitation

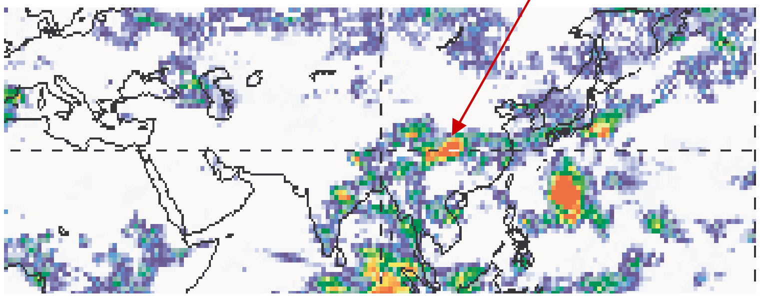
- MLS upper-trop clouds and water vapor reduced rapidly in early Sep 2004.
- MLS low-level clouds increased during the same period.
- The upper-trop anticyclone started to break down in early Sep 2004.
- What processes removed the upper-trop clouds and H2O?
- Rainfalls intensified in many South Asian regions as suggested by GPCP data (next slide).

Southern China



UKMO winds on September 3, 2004





The region where heavy rainfalls occurred was associated a strong downdraft. Severe flooding was reported due to rains on 3-5 September.

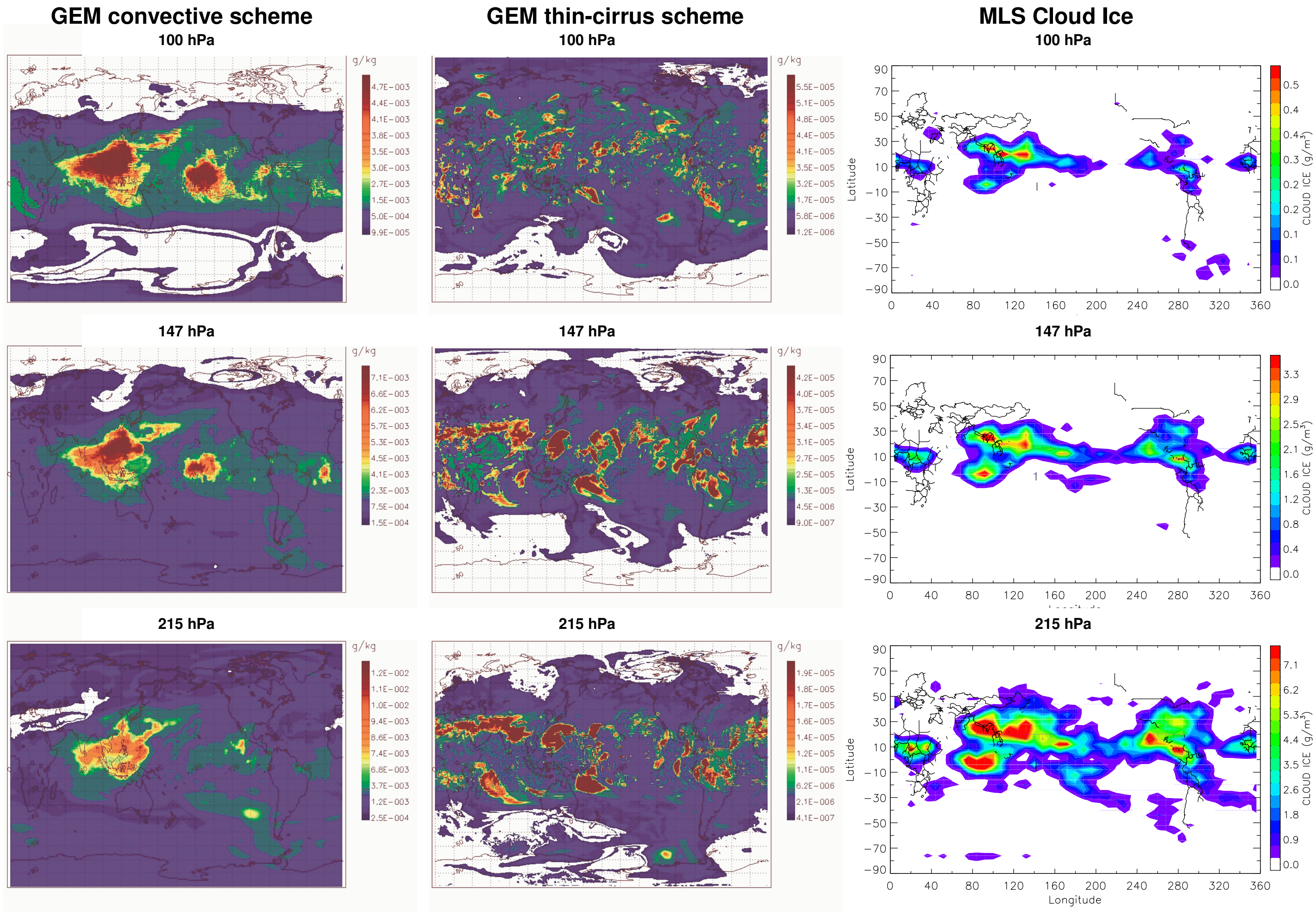
Local residents hold on to each other as they cross a swollen river in Kaixian, Chongqing, September 7, 2004. The death toll rose to 107 with another 88 missing in southwest China on Tuesday following a series of floods and mudslides. [Reuters]

The rain band progressed to southwest on the next few days as the 146-hPa anticyclone moves slightly to east.

Cloud Physics and Feedbacks

Aura-MLS vs. CCC GEM Cloud Ice (testing only) August 20-30 2004

(J.C. McConnell and the group)



GEM cloud ice are for scheme testing run only, not for real time comparisons.
(Not for Public Release. Credit: Jack McConnell and Carlo Buontempo)